C L A I M S:

1. Optical metrology method for determining the three-dimensional topography of an orifice, in particular for the measurement of micrometric, tapered nozzles and other similar devices (13), using illumination means (1) of the object to be analysed (14) and observation means (2) of the object to be analysed (14), which includes at least one camera (11), characterised in that it comprises an initial step for checking that the image plane (z) for said illumination means (1) coincides with the object plane for the observation means (2); the method further comprising the steps of:

- arranging the object to be analysed (14) on a microscope slide with the greater diameter opening facing the illumination means (1);

- centring one of the orifices (13) of the object to be analysed (14) in the field of view of the observation means (2);

- bringing into focus by means of wide-field illumination the smaller diameter opening of the orifice (13) to be analysed;

- measuring the diameter of the orifice as well as major defects such as the absence of an orifice or large-scale deformations;

- modifying the focus plane (z_i) of the inner part of the orifice (13) of the object (14) by changing it to another focus plane (z_{i+1});

- measuring the contour of the orifice (13) in the focus plane (z_{i+1}) in order to determine the inner topography of the orifice (13) by projecting a sequence of patterns and measuring the position of the points of the contour of the orifice (13) when the images of the projected pattern and their reflection on the inner walls of the orifice (13) are superimposed on the plane of the camera (11);

- repeating the above process for a number of

planes (z_i... z_n) inside the orifice (13);

- processing the data for the contours measured in the different planes to obtain a three-dimensional geometrical representation of the inner topography of the orifice (13), as well as its characteristic parameters (maximum and minimum diameters of the orifice (13), slope of the wall of the orifice (13), deviations from nominal figure, position of the axis of the orifice (13), etc.).

2. Method as claimed in claim 1, characterized in that said sequence of patterns are circular patterns of a given, increasing radius.

3. Method as claimed in claim 1, characterized in that the points of the contour on the focus plane (z_i) are measured using a cylindrical coordinate system with a resolution of 360-720 points measured along the length of the contour of the orifice (13).

4. Method as claimed in claim 1, characterized in that a series of images ranging from 10 to 25 in number is acquired in order to obtain the points measured along the contour of the orifice (13).

5. Method as claimed in claim 1, characterized in that the spacing between focus planes (z_i) ranges from 1 to 10 μm.

6. Method as claimed in claim 1, characterized in that the step of modifying the focus plane (z_i) of the object being analysed (14) by another focus plane (z_{i+1}) is repeated a given number of times to obtain values in just as many focus planes (z_n) within the orifice (13) of the object (14), depending on the thickness of the object being analysed and the requirements of the analysis parameters.

7. Apparatus for determining three-dimensional topographies, in particular for measuring micrometric tapered nozzles and other, similar devices (13) according to the method as claimed in any of the preceding claims, characterized in that it comprises illumination means (1),

observation means (2) and computer processing means (3), said illumination means (1) comprising a microscope objective (4) associated with said illumination means (1), a light source (5), a pattern representation system (6), and an optical system (8) associated with the illumination means (1); and said observation means (2) comprising a microscope objective (9) associated with the observation means (2), an optical system (10) associated with the observation means (2), and at least one camera (11, 18).

8. Apparatus as claimed in claim 7, characterized in that it includes a mirror (7) that deviates the light emitted from said light source at a certain angle (5) towards said optical system (8).

9. Apparatus as claimed in claim 8, characterized in that the angle of deviation of the light caused by the mirror (7) is 90°.

10. Apparatus as claimed in claim 7, characterized in that the objective (4) associated with the illumination means (1) is an 100X magnification SLWD objective (super-long working distance), whereas the objective (9) associated with the observation means (2) is a 50X magnification SLWD objective (super-long working distance), said camera (11) being a 1/3" camera.

11. Apparatus as claimed in claim 7, characterized in that said pattern representation system (6) is controlled by a computer (12) that forms part of said computer processing means (3) and allows to both visualise a wide-field illumination and to generate circular patterns of different diameters, said patterns being projected by means of said objective (4) with said optical system (8) inside the orifice (13) of the object being analysed (14).

12. Apparatus as claimed in claim 7, characterized in that said pattern representation system is a liquid crystal microdisplay (LCD) (6).

13. Apparatus as claimed in claim 7,

characterized in that said pattern representation system is a liquid-crystal-on-silicon (LCOS) microdisplay (16), and also includes a light beam splitter (17).

14. Apparatus as claimed in claim 7, characterized in that said light source (5) emits a broadband spectrum of light.

15. Apparatus as claimed in claim 7, characterized in that said light source (5) is a laser and the pattern on the inner surface of the orifice is generated using a scanner.

16. Apparatus as claimed in claim 7, characterized in that it includes an additional camera (18), said apparatus further including a light beam splitter (17').

17. Apparatus as claimed in claim 7, characterized in that said camera or cameras (11, 18) are CCD cameras.

18. Apparatus as claimed in claim 7, characterized in that said camera or cameras (11, 18) are CMOS cameras.

SUMMARY

"OPTICAL METROLOGY METHOD FOR DETERMINING THE THREE-DIMENSIONAL TOPOGRAPHY OF AN ORIFICE AND APPARATUS FOR DETERMINING THREE-DIMENSIONAL TOPOGRAPHIES ACCORDING TO SAID METHOD"

An optical metrology method for conical orifices according to the invention consists in arranging the object having the orifice under a microscope with the greater diameter opening facing illumination means and centring it in the field of view of observation means and bringing it into focus using wide-field illumination on the smaller diameter opening so as to measure its diameter and major defects. Subsequently, the focus plane is changed and the contour of the orifice is measured by projecting a sequence of patterns measuring the position of the points along the contour of the orifice when the images of the projected pattern and their reflection on the inner walls of the orifice are superimposed on the plane of the camera of the apparatus. The method is repeated and the data describing the contours measured in different planes are processed to obtain a three-dimensional geometrical representation and the characteristic parameters of the inner topography of the orifice.